

# **EXHIBIT A**



# Christmas Tree Notes

## Spruce Spider Mite on Fraser Fir

CTN-029

The spruce spider mite (SSM) (*Oligonychus ununguis*) is a common problem in Fraser fir Christmas trees and other conifers in western North Carolina. Considered a cool season mite in other parts of the country, temperatures in the mountains of North Carolina never get hot enough to slow this mite down. The SSM can therefore damage Christmas trees any time throughout the growing season.

### Spruce Spider Mite Damage

Spider mites have piercing and sucking mouthparts. Their feeding causes yellow spots on needles. From several feet away needles may appear generally yellow but when viewed close-up it can be seen that there are tiny yellow spots on the foliage. When damage is light, spots are found at the base of the needles. As mite numbers increase, the entire needle becomes spotted. The yellow spots merge and turn brown. Mite-damaged needles are more likely to fall off the tree, especially after the tree is cut. Occasionally there may be webbing present among the needles when the mites are actively feeding, similar to spider webs, hence the name, spider mite.

Spider mite damage can cause serious economic loss, especially if the trees are nearing harvest. In some cases, trees tagged for market have had to be left to grow another year or more after the SSM has caused so much damage that the plant is unsaleable. Damaged needles don't recover. They can only be hidden from view by new, green, undamaged growth. That may take one or two growing seasons, depending on the density of the tree and bud set.

Spider mite damage is never uniform across a field. Trees with heavy damage may be right next to trees with almost no damage at all. That is because trees vary in their susceptibility to spider mites.

**Time of Year for Damage to Occur.** Spider mite damage can occur on Fraser fir Christmas trees any

time from March through November. Damage to ornamental conifers such as dwarf Alberta spruce, hemlocks, and junipers grown in the foothills usually occurs in the spring. In the foothills, the spruce spider mite becomes less active in the hotter temperature of summer and other mites become a problem.

### Distinguishing between Rust Mites and Spider Mites.

Rust mites cause similar damage on both Fraser fir and hemlocks. Rust mite damage in the foothills is the most common problem, whereas spider mite damage on Fraser fir is more common. Rust mites are a springtime pest occurring as early as January in the foothills on hemlock and in March and April in Fraser fir in the mountains. Rust mites cause bronzing instead of yellowing on the foliage. When seen through a hand lens, rust mite feeding appears as scratches on the needles instead of the distinct yellow spots caused by spider mites.

**Post Harvest Spider Mite Problems.** The SSM can also survive on harvested trees and continue to feed and reproduce on the Christmas tree in the home. This occurs when the weather is mild during harvest and the mites have not become dormant. Homeowners have complained of webbing on trees, needle shed, and the mites themselves moving onto ornaments, presents, and furnishings.

### Finding the Spruce Spider Mite

It is important to be able to distinguish both spider mite damage and the mites themselves. Spider mite numbers increase and decrease rapidly, sometimes over the course of just a couple of weeks. If a field of trees isn't visited for a month or more, spider mites can easily build-up, cause damage, and then die out. Many growers have treated trees damaged by spider mites when no mites were left to control, wasting pesticide application without preventing damage.

**Spruce Spider Mite Appearance.** Spruce spider mites, like all mites of the tetranychid or spider mite group, have small, soft bodies with eight legs at maturity. These mites range in color from green to red, though in western North Carolina they appear dark red to almost black with lighter-colored heads and legs. The SSM egg is small and brilliant red with a single hair in the center. Eggs that have hatched appear clear.

**Spruce Spider Mite Location on the Tree.** Look for both mites and eggs on the most current growth of Fraser fir. The best time to look is on sunny days when the foliage is dry. Mites are usually more common on the lower half of the tree, and first appear on the smaller, interior shoots found partway into the canopy of the tree. Remember that mites cannot always be found on damaged foliage. If the damage occurred earlier in the year, the mites may have died out because of changes in the weather or natural predators. In the winter, only eggs are present unless the weather is mild.

### **Spruce Spider Mite Lifecycle**

The lifecycle of the SSM is simple. The mite overwinters as eggs on tree shoots. When temperatures are warm enough, the eggs hatch. The immature mite, or larva, is similar to the adult, only smaller, and has three pairs of legs instead of four. The larva molts to the nymph with has eight legs like the adult, but is slightly larger than the larva. Finally, the nymph molts to the adult. Both males and females are produced, females being larger than the males. During molting, the mites go through a resting stage where they don't move and may appear to be dead. At maturity, females mate with males, lay eggs, and the cycle begins again.

What makes the SMM such a dynamic pest is the speed with which this lifecycle can be completed. It can take as little as two weeks from egg to adult. Therefore, many generations occur each growing season, especially in the mountains where the mites can be active from early spring to late fall. In addition, at any given time during the growing season, all stages of the mite may be found. This affects pesticide performance as not all miticides control all stages. The egg state is particularly difficult to control.

### **Factors Affecting the Spruce Spider Mite**

With such high reproductive capabilities, spider mites would overwhelm all Christmas trees if there weren't factors keeping them in check. The most important

factor reducing mite numbers are natural predators, especially predatory mites. Other predators include hover fly larvae, lacewing larvae, dusty wings, and lady beetles. Predatory mites require high humidity to survive. That is one reason that the spider mite numbers rise during hot, dry weather.

Moisture also affects the spider mite itself. Rainfall keeps mite eggs from hatching, washes mites off of the tree, and allows a fungal parasite to kill both eggs and mites. In years with plenty of rainfall, spider mites are seldom a problem.

Temperature is the third important consideration. The spruce spider mite can live and function at low temperatures - even below freezing. However, the warmer the temperature, the faster it is going to be able to feed, mature and reproduce.

Field location and production practices influence mite activity. Growers can change their management practices to reduce problems with spider mites. Growers interested in producing organically grown Fraser fir for Christmas trees should be especially careful of field locations, which can create more problems with mites. Important factors are listed below:

- ✦ **Elevation.** In the mountains of western North Carolina, spider mites are more of a problem at lower elevations. Fields below 3,000 feet will almost always have spider mites every year. The warmer temperatures at lower elevations allow the mites to reproduce more quickly.
- ✦ **Aspect.** Fields facing south and west have more problems with spider mites than those facing north and east. Aspect affects both the temperature and the humidity at the site.
- ✦ **Rainfall.** Rainfall averages in western North Carolina range from less than 50 inches a year to over 100 inches. Some counties such as Ashe and Alleghany tend to have more problems with spider mites than counties such as Avery or Transylvania that receive more rainfall. In some years, though, problems with SSM are region-wide because of drought. Keeping track of rainfall in a field with a rain gauge can help determine when mites are more likely to be a problem. Fields receiving an inch of rain a week should have few problems with spider mites unless some other factor is creating a problem.
- ✦ **Air movement.** Trees grown on windy ridges typically have more SSM damage than those surrounded by woods which reduce air movement and foliage drying. In these protected fields, the

SSM is almost always present, but even during dry periods do not cause economic damage. That is because these habitats are best for predatory mites.

- ♦ **Dust.** Trees grown along dusty roads are most often the first to be damaged by the SSM. It is believed that the dust on the needles scratches the more active predatory mites, causing them to desiccate and die.
- ♦ **Pesticide use.** Some pesticides such as Thiodan, Sevin, and Asana are very broad spectrum and last a long time in the environment. These will kill off natural predators, allowing spider mite numbers to build. To avoid this problem, only use a pesticide against a pest when scouting results indicate that there is a problem. Use the least-toxic material available at the lowest effective rate. Control the balsam woolly adelgid from November through March when predators aren't present. Also during this time, materials such as horticultural oil, which are easier on the predators, can be used effectively. If fields are treated for woolly adelgid during the growing season, scout for spider mites more often, even into the following year.
- ♦ **Groundcover management.** Predators feed on insects and other mites, as well as pollen produced by flowers in the groundcovers in the absence of pests. When groundcovers are killed out, natural predators have lost an important habitat and they may not be present in high enough numbers to give control if spider mites should become active.

## Scouting for the Spruce Spider Mite

Even with a good location for Fraser fir production, judicious use of pesticides and proper groundcover management, spider mites can still be a problem. Many people depend on pre-budbreak pesticide applications for the control of the balsam twig aphid to give season-long SSM control. However, mite numbers can quickly increase with hot, dry weather even with effective spring controls. The only way to know if chemical controls are necessary and to avoid economic damage is by scouting.

**When to Scout.** Scout all Fraser fir fields from the year after planting through harvest to determine if mite numbers are great enough to damage trees. The number of times a field is scouted for mites depends on the size of the trees, the prevalence of SSM and the weather throughout the growing season. For trees that do not receive a balsam twig aphid or balsam woolly adelgid treatment in the spring, start scouting in early April. For trees that are treated in the spring,

scouting can be delayed until early June. Continue scouting until spider mites die out in the fall. This may take several hard freezes.

**The Scouting Block.** A block of trees is a group of trees that were planted at the same time. They represent a management unit that is treated the same way and should be scouted together. Blocks can be divided by field roads and still be considered the same block. Large fields can be broken into smaller blocks if desired.

**Scouting Pattern.** Use the rigid block scouting method for the SSM. Enter the block two to four rows from one corner. Record this row on the scouting form so that the survey will start on a different row the next time trees are scouted. Walk the full length of the row looking for early signs of SSM damage. At the end of the row, skip between 3 (for bigger trees 6-to-8 feet tall) to 5 rows (for small trees 3-to-4 feet tall) to come back. Continue this pattern covering the entire block.

**What to Look for When Scouting.** Scan trees while walking to find trees with SSM damage. From a distance, they may appear yellow or off-color. The earliest damage is usually found in the bottom third of the tree. Shoots back in the canopy though still the most current growth will show damage first. The stem that the needles are attached to stand out on damaged shoots. That's because there are yellow spots on the base of the needles closest to the stems. Get your eye accustomed to looking for this damage by finding problem trees, then stepping back several feet to see what they look like.

Growers that are colorblind may have a harder time detecting tree damage and even finding the red-colored spider mites. Find out who on your farm is best at scouting, and make sure they have the time to scout when needed.

**Taking Sample Shoots.** The scouting procedure requires looking at about 15 shoots per acre. This is only a number to aim for. If the exact acreage isn't known it doesn't matter. However, in small blocks of less than an acre, examine at least 10 shoots.

A single shoot of the most current growth is taken from trees that appear to have problems. Step out of the scouting row to examine these trees. If no damage is spotted, take a shoot at random from a tree about every 50 feet (every 10 trees). Whenever a sample is taken, walk at least another 30 feet (six trees) before sampling another tree, even if damaged trees are passed by. In this way the entire block is examined evenly.

It is only necessary to take a single shoot per tree, even if the tree has damage on it. Take the majority of the shoots from the bottom third of the tree, but also check a few shoots near the top of the tree. Look at the small shoots from inside the tree canopy rather than the larger exposed shoots, since mites are first found in the inner part of the tree.

**What to Look for on the Shoot.** Examine each shoot with a handlens for spider mites, spider mite eggs, and spider mite damage. There is no need to count the number of mites or mite eggs, only the presence or absence of mites and mite eggs.

Keep track of the number of shoots examined in a block on a counter. Keep track of the number of shoots infested with mites or mite eggs either in your head, or with a second counter.

**Economic Threshold.** The economic threshold is a way of describing pest numbers that have reached a point where pesticide intervention is necessary to prevent economic damage to the trees. Some slight amount of damage may occur even if the economic threshold isn't reached, but it will only affect a limited number of trees and shouldn't affect tree sales or tree quality.

The economic threshold for the spruce spider mite in Fraser fir Christmas trees is based on a percentage of trees infested in a field. The economic threshold changes with the size and value of the trees. Calculate the percentage by dividing the number of shoots with mites and/or mite eggs by the total shoots examined in a field and multiplying by 100. For instance, if 21 shoots are examined and 4 are found to have mites, the percentage of trees infested is estimated at 19%.

The economic threshold used by most growers is listed below. However, each grower has different needs for tree quality. These numbers should be adjusted up or down by each grower based on his or her own experience and needs.

Size of Tree	Economic Threshold
Less than waist high	40%
Waist high to year before sale	20%
Year of sale	10%

\*Percentage of infested shoots to sampled

**Modifying the Treatment Decision.** A grower may decide to delay treatment even if the economic threshold is reached. If the weather will be getting cooler or wetter, a pesticide treatment may not be necessary. Also, even if the economic threshold has just been met but there are a lot of predators present, delaying treatment may give the predators time to reduce spider mite numbers naturally. If treatment is delayed, be sure to scout again using the hot spot scouting method within a couple of weeks to see if spider mite numbers are in fact declining.

**Deciding When to Scout Again.** If the SSM percentages have not reached the economic threshold, decide when to scout again before leaving the field. Putting the next scouting trip on your calendar will help guarantee that the field will not be neglected during a critical time. The following will help decide when to scout again:

- ✦ Scout all go-to-market trees at least once a month.
- ✦ If no mites or eggs are found and no damage is seen on any of the sampled shoots and the trees won't be harvested this year, it is not necessary to scout again for 6 to 8 weeks.
- ✦ If less than 10 % of the shoots are infested and there is no new SSM apparent since the last scouting trip or pesticide treatment, return in 4 to 5 weeks.
- ✦ If more than 10 % of the shoots are infested, but it is less than the treatment threshold, return in 2 to 3 weeks.
- ✦ If there are more than 10 days of hot, dry weather, return sooner than scheduled.
- ✦ If the trees do require a pesticide treatment, plan to scout again after treatment to determine if it was successful.

**Records.** Mite numbers rise and fall. This is only apparent when the scouting results of one scouting trip are compared with another. Therefore it is important to keep accurate records. Record the date trees were scouted, the row scouting was started on, the weather conditions during scouting, the number of shoots examined, and the percentage of trees infested. Make some notes as to the level and severity of damage found. Record whether mostly eggs, immature mites or adults were found. Also record if any natural predators were present. Have these notes in hand the next time the field is scouted so that changes can be evaluated.

**Hot Spot Scouting.** Hot spot scouting is quicker and easier than rigid block scouting. The "hot spot" is an area of the field where mites were first found and are most active. It may be on a windy ridge or along a dusty road. Or it may be a single tree that always gets damaged before any other tree in the field (sometimes referred to as a "mother tree"). Hot spot scouting is not a replacement for rigid block scouting but it is a way of checking to see if the weather or predators are reducing mite numbers, or to see if pesticide treatments have worked.

Identify the hot spot through other scouting methods. Mark the area with flagging in the field and on a field map. If mite activity is increasing in hot spots, go back and use the rigid block scouting method over the entire block to determine if treatment is necessary.

**Scouting Large Acreage.** Some growers may have five or more acres planted all at the same time and managed the same way. This large of an acreage can take a long time to scout using strict rigid block scouting methods. When trees are not close to market, or are being grown for #2's or chain-store markets that do not require perfect trees, short cuts can be taken. First examine areas where spider mites are likely to develop to get an indication of mite activity. Go to dusty roads, windy ridge tops, and south or west facing slopes first. If no mites are found in these areas, it is unlikely that they are found anywhere else in the field. By scouting this way when trees are small, a pattern of mite activity can be learned before trees near harvest. Consistent scouting over the rotation is necessary to make this scouting scheme work. Rigid block scouting is better – but for large growers who wouldn't have time to anything more than this – it may be good enough.

## Chemical Control

Any time a grower treats for insects in Christmas trees, it is important to consider mite control as well. As already stated, many insecticides can cause mite flare-ups. When treating for hard to control pests such as the balsam woolly adelgid, consider adding a miticide if any mites are present, even if treatment thresholds have not been reached.

When scouting results determine that the treatment threshold has been reached, treat promptly for the SSM. Treat the entire block, even if only one area has

mites. In all likelihood these unaffected areas will get mites and require treatment if left alone.

Chemical control of the SSM is difficult because good spray coverage is essential for good control. Chemical control is also made more difficult because miticides work in different ways. Most don't control all the stages of mites. Some do not kill the eggs and must be reapplied within 10 to 14 days to control the newly hatched immatures. Others control only the eggs and immature mites and not the adults. Also some miticides control only spider mites and not rust mites.

Most growers also try to control other pests when treating for spider mites, hoping to get the most out of the effort of applying a pesticide. Consider the time of year to determine if it is possible to control other pests as well.

**Application Methods.** The method of applying a pesticide will determine how well it works just as much as the material that is chosen. In Christmas trees, tractor-driven air-blast mistblowers are the fastest way to apply pesticides. However, the coverage is not always adequate to control spider mites. Having access roads every 12 to 15 rows and treating from opposite sides of the block will aid in getting good coverage. Be sure to scout after application and especially in the middle of the field where the pesticide may not have been applied heavily enough.

The best foliar applications are made with high-pressure sprayers and a hand-held gun. Don't treat trees as you would for the balsam woolly adelgid. Create a fog instead of a straight-stream using pressure lower than 200 pounds per square inch.

For spot treatments or for growers who do not have many trees, a back-pack mistblower is a good way to apply miticides.

**Miticides.** Several new miticides have come on the market within recent years. The following is a current list as of November 2009. The mode of action is listed for each material. Do not use the same miticide year after year as spider mites can become resistant. It is a good idea to vary materials from different chemical families as well. Your local county extension agent can help in making this decision.

<b>Miticide</b>	<b>Common Name / Chemical Family</b>	<b>Description</b>
Avid	Abemectin	This miticide is quickly absorbed by the plant and kills the mite as it feeds. Since it remains in the plant for 2 weeks or more, it should kill any mites that hatch from eggs, even though it has no activity against the egg itself. The material paralyzes mites by increasing the release of the inhibitory neurotransmitter gamma aminobutyric acid (GABA) from nerve terminals inside the pest. After spraying, mites may appear normal, but they cannot feed or cause damage and within a few days they die. However, field control has been mixed in western North Carolina. Controls only the spruce spider mite.
Cinnamite	Cinnamaldehyde	This material kills mites on contact. Eggs are not affected. To achieve good results, two applications made 10 to 14 days apart will be necessary. Also has some activity against the balsam twig aphid.
Dimethoate or Cygon	Dimethoate Chemical Family: organophosphate	This is a nerve poison. It does not control the mite egg and needs to be reapplied in 10 to 14 days if mite eggs are present when trees are treated. It also controls the balsam twig aphid, hemlock rust mite and elongate hemlock scale.
Envidor	Spirodiclofen Chemical Family: tetrionic acid derivative	Envidor is a lipid biosynthesis inhibitor. It has activity against both rust mites and spider mites and lasts long enough to control the immatures that hatch from the eggs. Use it at the higher labeled rate to control spider mites and the lower rate to control only rust mites.
Floramite	Bifenazate Chemical Family: carbazate	This material also acts as a GABA inhibitor. It is persistent in plant foliage for more than 21 days. It is active against all stages of mites. Field trials in Fraser fir have been mixed and Floramite is only active against the tetranychid or spider mites.
Horticultural Oil		These materials kill mites and insects by smothering them. May have some limited activity against the spider mite egg but usually has to be reapplied within 10 to 14 days. Most oils are petroleum based, but some are vegetable based. Horticultural oil can burn foliage if agitation is not adequate.
Lorsban	Chlorpyrifos Chemical Family: organophosphate	This is a nerve poison. It does not control the mite egg and needs to be reapplied in 10 to 14 days if mite eggs are present when trees are treated. Also controls the balsam woolly adelgid, balsam twig aphid, and hemlock rust mite.
Metasystox-R	Oxydemeton-methyl Chemical Family: organophosphate	This is a nerve poison which is very toxic. It does not control the mite egg and needs to be reapplied in 10 to 14 days if mite eggs are present when trees are treated. Also controls the balsam twig aphid and hemlock rust mite.
Oramite	Propargite	This material works by contact so thorough coverage is necessary
Sanmite	Pyridaben Chemical Family: pyridazinone	This material, which works on contact, is a mitochondrial electron transport inhibitor (METI), which blocks cellular respiration, causing the pest to lose coordination and eventually collapse. It also controls the hemlock rust mite.

Miticide	Common Name / Chemical Family	Description
Savey	Hexythiazox	This material controls the mite eggs and immature mites but has little activity against the adult. The pest is controlled when it either walks across the residues on needles, or an egg is laid on the residue. It interferes with the mite's ability to produce the chitin in its exoskeleton. Either apply this material when about 10 to 25 % of the mite eggs have hatched in the spring and no adults are present, or mix with another miticide which doesn't control mite eggs, such as dimethoate. Controls only the spruce spider mite. Only apply this material once per year.
Talstar	Bifenthrin Chemical Family: synthetic pyrethroid	Talstar has activity against spider mites but not rust mites. It lasts long enough on the foliage to kill the immatures that hatch from the eggs. However, use of Talstar often creates subsequent problems with rust mites.
Thiodan	Endosulfan Chemical Family: organophosphate	This nerve poison is very toxic. It does not control the mite egg and needs to be reapplied in 10 to 14 days if mite eggs are present when trees are treated. Also controls the balsam woolly adelgid, balsam twig aphid, and hemlock rust mite.

**Scouting after Pesticide Application.** These miticides require good coverage to give good results. It is important to scout, using the hot spot scouting method, after pesticide application to determine if adequate control was achieved. Wait at least 1-to-2 weeks after application before scouting. Don't be

fooled by immature mites that are molting. These may appear dead when they aren't. If there is any question, remove a branch with mites and look at it again the following day.

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